

## Editorial

### Self-citation in Publishing

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#### Introduction

A scientific journal first appeared in 1665; citation of manuscripts began in 1752 [6, 34]. In 1955, the impact factor (IF) was proposed by Eugene Garfield as a simple method to calculate the relative frequencies of citations between journals (Fig. 1) [21]. Subsequently, the IF was used to select journals for the Science Citation Index (SCI), a commercial property of the Institute of Scientific Information (ISI; Philadelphia, PA, USA) and founded by Garfield in 1961 [21]. (ISI subsequently was acquired by Thomson Scientific & Healthcare in 1992, a company that then subsequently became Thomson Reuters.) Beginning in

1975, the IF was incorporated into the newly developed annual Journal Citation Reports (JCR).

Thousands of scientific journals are now listed in the JCR. Although not intended as such and not appropriate for doing so, the IF is widely viewed as a measure of prestige of a journal and indirectly of authors publishing in those journals. Although the IF is probably the most widely used metric to rank journals, such rankings are subject to numerous issues and one can raise some questions regarding the rankings: What are the biases of the IF? Is it easy for editors to manipulate it? Do other citation metrics overcome the potential for misinterpretation? How do these influence journals' ranking?

There are numerous sources of potential bias in the rankings, some inherent in the system and some not: self-citation (articles from the same journal), citation density (the number of references listed), quality of citations, poor comparability between different specializations, mainly use of English language in publications, type of manuscripts, ease of access, and journals not listed in the SCI database are major disadvantages of the IF [1, 5, 14, 16, 19, 20, 25, 26, 31, 35, 40, 43, 47, 49]. Based on the IF, a citation from an important journal such as Nature is worth no more than a citation from journals in the lowest tiers of publishing [3, 45]. Considering that the SCI database lists only approximately 5000 journals of an estimated total of 126,000 [36, 47, 52], 121,000 journals not listed in the SCI often are referred to as having no IF [35].

Self-citation ranges from 7% to 20% of an article's references [13, 16, 17, 25, 38]. High self-citation is more common for specialized journals [11, 16, 25, 38, 51] and articles with many authors [13]. Thomson Reuters considers self-citation beyond 20% as suspect of abuse as the journal's IF is higher and prestige enhanced by self-citation

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$$2008\text{ IF} = A / B$$

*A* = the number of times articles published in 2006 and 2007 and cited by indexed journals during 2008

*B* = the total number of citable items published in 2006 and 2007.

*2008 IFs are actually published in 2009; they cannot be calculated until all of the 2008 publications have been received by the indexing agency.*

**Fig. 1** The IF of a journal equals the ratio of the number of citations in the current year to articles published in the journal in the 2 preceding years divided by the number of citable items published in these 2 years.

[13, 16, 17, 19, 20, 25, 31]. The potential for abuse and manipulation of the traditional IF highlights the need for and use of self-citation-free metrics for scientific evaluation.

It is not unethical and is even the duty of responsible editors to increase the quality and interest of their journal. It would be unfair to authors and disloyal to publishers if editors did not act in this direction [33]. However, it is easy for editors to manipulate the IF. Editors may artificially increase their journal's IF by (1) facilitating (or even demanding) self-citation [11, 12, 24, 27, 39, 42, 47, 48, 50, 51], (2) increasing nonsource items with citations, (3) limiting the total number of articles and/or the number of original papers and increasing the number of review and/or technical articles that are more likely to be cited [11, 27, 35, 42, 47, 51], (4) encouraging "salami slicing" [4, 22, 37], and (4) prerelease or timing of publication early during a year thus allowing more time for citation for a given year [19, 28, 49, 51]. Excessive self-citation may cause a large shift in a journal's IF, particularly if the total rate of citations of that specific journal is low [11, 32, 51]; one journal's IF increased 18 ranks by one paper containing 303 self-citations [32]. There is clear documentation of editorial feedback to corresponding authors to include self-citations [4, 22, 33, 35, 37]. In addition some editors have used their journal as a personal vehicle for dissemination and promotion of their own work, and placing their articles higher in the publication order [7, 8]. Clearly, this is neither fair nor ethical.

The JCR defines original papers, technical notes, reviews, and proceedings as source items; these items make the denominator of the IF [18, 30, 35]. Nonsource items, including letters, news, abstracts, book reviews, and editorials, are not typically included in the denominator, but if they contain citations, they may be included in the numerator, thus increasing the IF [23, 42, 47, 52]. Increasing the nonsource items, such as by encouraging letters to the editor containing self-citations of the articles being discussed, reference to previous editorials, or running large correspondence sections, is an easy way to increase the IF by increasing self-citation without increasing the source items [11, 27, 33, 35, 42, 47, 51].

Encouraging "salami slicing", whereby research data and manuscripts are broken into "least publishable units"

but more articles, particularly with self-citations, is another method to increase the IF [4, 22, 37].

Considering the 2-year sample period, a paper published in January has 11 months longer to be cited than one published in December of the same year [11]. Moreover, prerelease of article details (soon-to-be-published, ahead of print) increases the immediacy of impact [35].

### Self-citation-free Metrics

The SCImago Journal Rank (SJR) indicator measures the prestige transferred to a journal through the citations received from other journals by computing the percentage of citations of the former journal directed to articles of the latter journal during the past 3 years [14, 46]. Major advantages over the IF include the elimination of self-citations in determining the impact or prestige of a journal [14, 46], the quality of citations are based on the prestige of the citing journal [14], a higher number of journals and languages are in its database, and the SJR is freely available without a subscription (JCR requires a subscription) [14, 15, 41, 49]. Major shortcomings of the SJR indicator include the sophisticated calculation methodology and the fact that it divides the prestige gained by a journal to the total number of its articles during the 3-year period being reported [14]. Thus, nonsource items that could be of interest to the readers may be appreciably underestimated with the SJR indicator [14].

The Eigenfactor™ score measures the number of times that articles published during 1 year cite papers published in the 5 previous years (Fig. 2) [2, 3, 10, 44]. There is a strong correlation between the Eigenfactor™ score and the 'total cites' received by a journal [9]. Like the IF, the Eigenfactor™ score is essentially a ratio of the number of citations to the total number of articles [1]. Unlike the IF, it counts citations to journals in the sciences and social sciences, discounts self-citation, and weights each reference according to a stochastic measure of the amount of time researchers spend reading the journal [10, 29]. The Eigenfactor™ score is available only for JCR years 2007 and later [29].

The Article Influence™ score reflects a journal's prestige based on per article citations (Fig. 3). It is comparable

**Fig. 2** The Eigenfactor™ score measures the number of times articles from a journal published during the past 5 years have been cited in the JCR year by direct citation counts from a matrix that records how often each journal cites each other journal. (The formula is published with permission from Eigenfactor.org.)

$$EF = 100 \frac{H\pi^*}{\sum_i [H\pi^*]_i}$$

$\pi^*$  = the leading eigenvector of a stochastic matrix which corresponds to the fraction of time spent at each journal

$H$  = a cross-citation matrix normalized by the number of outgoing citations in journal  $j$  to articles in journal  $i$

$$H_{i,j} = \frac{Z_{i,j}}{\sum_k Z_{k,j}}$$

$Z_{ij}$  = the number of citations from articles published in 2006 in journal  $j$  to articles in journal  $i$  for the 7,611 ISI-linked science and social science journals published in 2001-2005

$$AI_i = 0.01 \frac{EF_i}{\alpha_i}$$

$EF_i$  = the Eigenfactor™ Score for journal  $i$

$\alpha_i$  = the  $i$ -th entry of the normalized article vector

**Fig. 3** The Article Influence™ score for each journal is a measure of the per-article citation influence of the journal during a 5-year period. The Article Influence™ score ( $AI_i$ ) equals to the ratio of the journal's Eigenfactor™ score divided by the fraction of articles published by the journal. (The formula is published with permission from Eigenfactor.org.)

**Table 1.** ISI Web of Knowledge ranking based on 2009 JCR Journal Impact Factor (2009 Journal Citation Reports®—Science edition, a Thomson Reuters product)

Rank	Journal abbreviation	ISSN	Journal impact factor
1	Osteoarthritis Cartilage	1063-4584	3.888
2	Am J Sports Med	0363-5465	3.605
3	J Bone Joint Surg Am	0021-9355	3.427
4	J Orthop Res	0736-0266	3.112
5	Spine J	1529-9430	2.902
6	J Bone Joint Surg Br	0301-620X	2.655
7	Spine	0362-2436	2.624
8	Arthroscopy	0749-8063	2.608
9	Gait Posture	0966-6362	2.576
10	J Orthop Sports Phys Ther	0190-6011	2.482
11	Injury	0020-1383	2.383
12	Phys Ther	0031-9023	2.082
13	Clin Orthop Relat Res	0009-921X	2.065
14	Eur Spine J	0940-6719	1.956
15	J Shoulder Elbow Surg	1058-2746	1.934

(Data obtained and published with permission from Thomson Reuters.)

to the IF without self-citation. It is normalized so that the sum total of articles from all journals in the JCR database is 1.00. A score greater than 1.00 indicates that each article in the journal has an above-average influence as the average

**Table 2.** ISI Web of Knowledge ranking based on journal total cites (2009 Journal Citation Reports®—Science edition, a Thomson Reuters product)

Rank	Abbreviated journal title	ISSN	Total cites
1	J Bone Joint Surg Am	0021-9355	31,317
2	Spine	0362-2436	30,673
3	Clin Orthop Relat Res	0009-921X	29,213
4	J Bone Joint Surg Br	0301-620X	16,267
5	Am J Sports Med	0363-5465	13,031
6	J Orthop Res	0736-0266	9974
7	Arthroscopy	0749-8063	7547
8	Osteoarthritis Cartilage	1063-4584	6425
9	J Arthroplasty	0883-5403	6147
10	Acta Orthop	1745-3674	6086
11	J Hand Surg Am	0363-5023	5871
12	Injury	0020-1383	5647
13	Phys Ther	0031-9023	5568
14	J Pediatr Orthop	0271-6798	4612
15	Clin Biomech	0268-0033	4537

(Data obtained and published with permission from Thomson Reuters.)

article in the JCR database, whereas a score less than 1.00 indicates below-average influence [2, 29]. The theory behind the Eigenfactor™ and Article Influence™ scores is that one citation from a high-quality journal has more value than multiple citations from more peripheral publications [1, 2, 10, 29].

By ranking orthopaedic journals with self-citation-free factors rather than with the IF, substantial changes for journal ranking occur; specialized journals decrease, whereas general journals increase in rank [10, 29, 43, 49]. We examined the first 15 orthopaedic journals in the 2009 JCR IF rank (Table 1) [29]. When we looked at the total cites rank, the ranking of journals changed surprisingly: some journals increased in rank and others decreased in rank (Table 2). Total cites is the total number of times that a journal has been cited by all journals included in the database in the

**Table 3.** ISI Web of Knowledge ranking based on Eigenfactor™ score (2009 Journal Citation Reports®—Science edition, a Thomson Reuters product)

Rank	Abbreviated journal title	ISSN	Eigenfactor™ score
1	Spine	0362-2436	0.05135
2	Clin Orthop Relat Res	0009-921X	0.04063
3	Am J Sports Med	0363-5465	0.02739
4	J Orthop Res	0736-0266	0.02279
5	Osteoarthritis Cartilage	1063-4584	0.02120
6	Arthroscopy	0749-8063	0.01802
7	J Arthroplasty	0883-5403	0.01597
8	Eur Spine J	0940-6719	0.01504
9	Injury	0020-1383	0.01380
10	Gait Posture	0966-6362	0.01359
11	Clin Biomech	0268-0033	0.01200
12	Spine J	1529-9430	0.01083
13	Knee Surg Sports Traumatol Arthrosc	0942-2056	0.01034
14	Acta Orthop	1745-3674	0.00977
15	Phys Ther	0031-9023	0.00929

(Data obtained and published with permission from Thomson Reuters.)

**Table 4.** ISI Web of Knowledge ranking based on Article Influence™ score (2009 Journal Citation Reports®—Science edition, a Thomson Reuters product)

Rank	Abbreviated journal title	ISSN	Article Influence™ score
1	Osteoarthritis Cartilage	1063-4584	1.278
2	Am J Sports Med	0363-5465	1.140
3	J Orthop Res	0736-0266	1.038
4	Gait Posture	0966-6362	0.961
5	Clin Orthop Relat Res	0009-921X	0.838
6	Spine	0362-2436	0.834
7	BMC Musculoskelet Disord	1471-2474	0.813
8	Phys Ther	0031-9023	0.802
9	Clin Biomech	0268-0033	0.765
10	Orthop Clin North Am	0030-5898	0.739
11	Eur Spine J	0940-6719	0.710
12	Arthroscopy	0749-8063	0.687
13	J Orthop Trauma	0890-5339	0.617
14	Clin J Sport Med	1050-642X	0.615
15	Knee Surg Sports Traumatol Arthrosc	0942-2056	0.589

(Data obtained and published with permission from Thomson Reuters.)

JCR year. However, how many of these are self-citations? In the JCR, self-citations for each journal can be calculated separately. However, the IF without self-citation is not

incorporated in the calculation of the journals' IF [29]. By limiting to the Eigenfactor™ score (Table 3) and the Article Influence™ score (Table 4) that eliminate self-citations, ranking of the journals changed. Considering the calculation methodology for these metrics, this should be attributed to the high total cites and/or low self-citations during a 5-year period for the journals that increased in rank contrary to the journals that decreased in rank [10, 29].

Readers should understand self-citation may substantially affect a journal's IF compared with IFs of other journals in the same specialty, self-citation is prone to manipulation and abuse, and the IF does not account for self-citation. Self-citation can bias how a journal is perceived but the bias can be overcome by ranking journals by self-citation-free indices.

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